COMMENTS ON THE DESIGN OF INSECT NETS[1]

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The traditional tool and symbol of an entomologist is an insect net, much as a tennis racket, fishing rod, golf clubs, or a baseball bat symbolize certain other activities. Entomology, unlike these other activities, has never taken the design of its most common piece of equipment very seriously. While fishing rods and golf clubs have been developed to exquisite instruments of balance and controlled power, uniquely suited to their jobs, the insect net has remained a clumsy piece of apparatus, inexpertly designed and crudely manufactured. One can order from a supply house their "best" insect net, and receive something engineered more with attention to its being collapsible than to its function of catching insects.

Probably a reason that insect nets are not better than they are, is that few entomologists are really good collectors, or even know what kind of results a good collector should expect from a day's work. If their clumsy nets lower their collecting scores by 10% or 30% they hardly know the difference. There is so little direct competition between collectors that faulty equipment or techniques usually remain uncensored, and even are taught to new generations of collectors. When a good design is at times generated,

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its merits and details are often forgotten and new collectors may start all over again with an inferior design or an inferior copy.

Since insect collectors differ in the insects they seek, and in their choice of hunting grounds, no one design can be best for all persons and all terrains. It follows that a collector should have more than one type of net, for use in different situations, not as many types as there are of golf clubs, but enough to fit the main kinds of vegetation that he encounters.

Too much attention is given to making nets collapsible. It is difficult to have the joints necessary for collapsibility without sacrificing lightness, strength, and rigidity. A collapsible net makes sense only if the net must be carried for only short time or sporadic use. One would not dream of using collapsible skiis nor a collapsible tennis racket and if one wants to be a good insect collector probably neither should he emphasize a collapsible net.

A net should be light enough to be swung quickly, yet heavy enough to crash through vegetation. These two opposing needs require a compromise. A man's net should be a bit heavier than a woman's. His strength can more easily offset the weight of the net, and the weight will often be useful for whacking specimens out of vegetation. Vegetation varies in density and stiffness, and a lighter net is better for soft vegetation and a heavier one for stiffer plants. A well equipped collector should have nets of two weights.

The handle of a net should be tapered, large enough at the grip to be easily held and smaller toward the ring so that it is easy to swing quickly. Unless it is tapered, the distal part is too heavy for a quick swing. Most nets neglect this important design feature.

The bag of most nets is made for butterflies, deep enough for keeping the butterfly from easy escape and roomy enough to give the butterfly some fluttering space. Most collectors do not specialize in butterflies and should have a somewhat differently shaped bag. A deep net has two disadvantages: there is more netting to get tangled in bushes, and it requires a deeper reach to take out the captured insect. A deep net makes it harder for the insect to escape, but a good collector substitutes skill for this disadvantage and finds that quicker access to the specimen means less time spent before he is ready to catch another.

The net handle plus the ring should be long enough to reach the ground two feet in front of the collector, but not longer unless one is after butterflies. A net ring twelve inches in diameter is usually a suitable size. Fifteen inches is often used for heavier sweeping nets and a ring this size is sometimes favored by butterfly collectors. Miniature nets of four to six inches in diameter and with a very short handle are useful for picking up a specimen when making behavioral studies, and are also often efficient for collecting on tree trunks, logs, rocks, or on the ground.

For net bags, the easiest material to find is Dacron (or Terylene) marquisette, 25 meshes per inch. This is carried by the yard in curtain departments of larger stores, or sometimes has to be bought in ready-made curtains which can be cut up. This material, though otherwise excellent, has the disadvantage of snagging and pulling easily. A net bag made of Dacron is good for less than a month of hard use. Tighter weaves of Dacron or nylon are much better for wear but are hard to find in stores and are less transparent. Transparency is important for ease in dealing with specimens in the net.

Sweeping nets are usually made of tightly woven fabric but this is not best. The net should be as porous as possible to allow the air to go through. A tightly woven net causes more air resistance, and stronger eddy currents that carry flying specimens around rather than into the approaching net. Speed of movement of a sweeping net is important for a good catch. Any slowing by air resistance cuts down on the number of specimens, and biases the catch toward the more sluggish species. The hard wear given a sweeping net is the reason that tightly woven cloth is usually selected. New, stronger materials such as nylon and Dacron permit a porous net also to be wear resistant. Even with nylon or Dacron, however, the weave should not be so open that it is easily snagged.

The net bag should be white. Darker colors are sometimes advocated because they are supposedly less readily seen by the insects. This theoretical advantage is of less importance than the ease of finding insects in the net and extracting them after they have been caught. In a dark colored net a small insect is difficult to locate, so at least for smaller insects, a dark net is a disadvantage. For larger specimens, if there is an advantage, it has not been documented.

The bag should hang smoothly from the net ring and taper toward a parabolic bottom. Corners in a net are a nuisance, and if it ends in a point, specimens and foliage tend to pack into the point. Few net bags hang smoothly because the pattern of their cut makes the lateral sides of the bag shorter than the outer and inner sides, with resultant pucker along the outer and inner sides. Some manufacturers get a smoother hang to the bag by making it out of four parts, but there is an easier way to that end, as indicated below.

There is not a big market for insect nets, and even a professional entomologist would sooner spend $125 for a pair of skiis than $25 for an insect net. One would think that a well-constructed, finely balanced net should excite enough pride of ownership and satisfaction in more efficient collecting to bring a substantial number of purchases and to justify the engineering and manufacturing costs, but it should be remembered that many entomologists spend more time on skiis than with a net. Profit from supplying good quality nets is not assured.

The entomologist who needs a good net, suitable for his special needs, usually has to make his own. Below is described a pattern for a net that is light and fast, useful for quick insects such as Hymenoptera and Diptera. The basic design of the frame is well known and one that can be modified for various kinds of collecting. Most of the best manufactured nets follow this basic pattern, substituting a ferrule for attaching the wire ring in place of the tie wires described below. The manufactured examples usually do not have tapered handles and the apical right angle bends on the wire are too short. Their net bags are too deep.

The ring of the net described below is of steel wire, preferably galvanized; 8 gauge for a medium weight net, 10 gauge for a lighter net. Spring steel wire should be used if possible because it keeps its shape and is extra strong. Unfortunately spring steel wire is not available in the average hardward store. A ring can also be made from "cold-rolled steel" rod. Cold-rolled steel is stiffer than common wire, but finding rod of the diameter wanted can be difficult.

A piece of wire four feet long is enough for one 12 inch net ring. Bend it as illustrated in figure 1. The sequence of bends is first a right angle of 3/8 inch, then measure 2-3/4 inches from this and bend at right angles again in the opposite direction, then measure 37-1/4 inches further and bend again at right angles in the same direction. Measure 3-1/4 inches further and bend again at right angles in the opposite direction. Saw, clip, or file off the last end so it projects 1/2 inch beyond the last bend. All bends are made by clamping the wire in a vise and bending against the vise. Hit the first and last bends with a hammer to make them sharp bends. The second and third bends should not be hammered as this will weaken the points where there is strain. When a net ring breaks it is always at one of these two bends. With the hands, bend the wire between the second and third angles into a circle, as illustrated.

The net handle is made of a dowel stick (maple) one inch in diameter (obtainable from a lumber yard) or an old broom handle. Select a stick with straight grain. The handle length I use is 28-1/2 inches. Taper the handle to 5/8 inch diameter at the ring end to cut down on weight, leaving the first 6 inches full size for a handle grip. To make the taper, use a wood plane and plane opposite sides down until there is only 5/8 inches between them except near the grip portion. Then plane down the other two sides until the cross section is 5/8 inch square. Plane off the corners of the square to make an octangonal prism of 5/8 inch, then round off the eight corners until the handle is smoothly rounded.

Drill a hole directly through the handle 3-1/4 inches from the small end and of exactly the same diameter as the wire ring. Drill a second hole 2-3/4 inches from the end and in exactly the same plane as the first hole. Put the end of the handle in a vise, with the holes exactly vertical, and make a shallow groove with a saw from the first hole to the tip. Turn the handle over in the vise and make a similar groove from the second hole to the tip. With a pocket knife widen and deepen these grooves until the apical bends of the net ring can be inserted into the holes in the handle and the adjoining wire segments lie snugly in the grooves. Take the wire ring off the handle and with a pocket knife cut a shallow groove around the handle at 1/4 inch from the end and another at 2-1/2 inches

from the end. Sandpaper the handle smooth with fine sandpaper and finish it by rubbing with floor wax.

The pattern for the bag is shown in figure 2. Noteworthy features are a rounded bottom whose apex is a little toward the handle side rather than at the center. This is to counteract a tendency for the bottom to swing outward when the net is swung. Swinging outward tends to result in snagging in the bushes. The top edge of the pattern is an arc drawn with a pencil on a string, the end of the string held at the apex of the net bottom. This peculiar feature makes the bag hang straight when on the ring. If the top of the pattern were cut straight across, the distance from the edge to the bottom would then be greater at some places than at others, resulting in puckering of the bag. This net bag is a short one for fast collecting. Beginners might want it a few inches longer. The pattern should be cut out of paper, positioned over a double thickness of the fabric, and pinned in place before cutting. Sew the two fabric halves together with a flat, double stitched "French fell". Leave about 4 inches at the handle side open, unsewn.

The sleeve for holding the bag to the net ring is of muslin, a piece 4-1/2 inches wide and 48 inches long. If the net is a strong one, to be used for sweeping, the sleeve should be of Dacron or nylon to withstand the extra wear. Crease the sleeve piece as in the figure, pressing the crease with a hot iron. Pin its middle at the middle of the upper edge of the bag, at the point farthest from the place for the net handle. Then pin the rest in place along the edge, and stitch. Several inches of the sleeve will be left projecting at each end.

For putting a new bag or a replacement bag on the net frame, thread the wire hoop through the sleeve, insert the ends of the wire hoop into the two holes in the handle, squeeze them in snugly, and bind the hoop in place with 2 or 3 turns of thin wire in the two circular notches near the end of the handle. Twist the ends of the binding wire tightly together and cover them with a band of adhesive tape to keep the wire ends from catching the net bag. There is an open throat of the net bag at the handle. Pin this together, overlap the ends of the sleeve, trim off excess ends of the sleeve, and sew these together neatly with a needle and thread.

For an extended collecting trip, the entomologist should take not only more than one kind of net but at least one extra wire ring for each net and several extra bags.

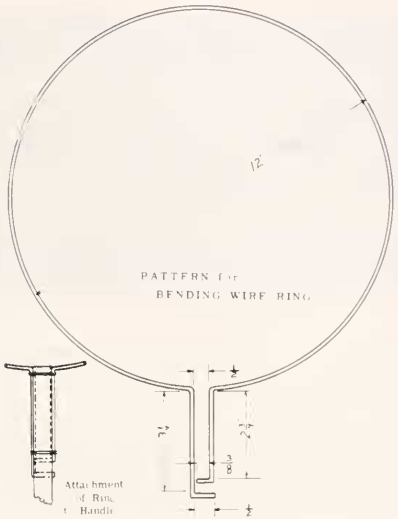

Figure 1. Wire ring for an insect net.

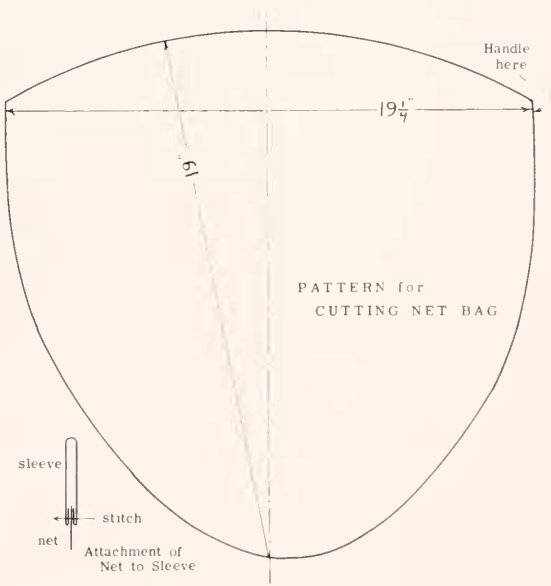

Figure 2. Pattern for cutting the bag of an insect net.